imaging the surface to form a defect image;

classifying the defect as being in one of a predetermined number of core classes of defects; and

classifying the defect as being in one of an arbitrary number of variant subclasses based on the classification of the defect as being in the one core class and based on training by the user with a set of sample defect images.

REMARKS

Claims 1-30 are pending in the application. Claims 1, 10, 19 and 22 have been amended.

In the Office Action, claims 1 and 3-5 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent 6,047,083 (Mizuno). Claim 2 was rejected under 35 U.S.C. §103(a) as being unpatentable over Mizuno in view of the article entitled "Automatic defect classification for semiconductor manufacturing" by Paul B. Chou et al. ("Chou"). Claim 6 was rejected under 35 U.S.C. §103(a) as being unpatentable over Mizuno in view of the discussion at page 11, lines 7-30 of the present application. Claims 7-9 were rejected under 35 U.S.C. §103(a) as being unpatentable over Mizuno in view of U.S. Patent 5,172,421 (Nakamura). Claims 10-30 were rejected as claims 109, because they are claiming similar subject matter as claims 1-9. These rejections are respectfully traversed. Applicant respectfully requests reconsideration and allowance of the claims in view of the following arguments.

The present invention relates to a method and apparatus for automatically classifying a defect on the surface of a semiconductor wafer. According to certain embodiments of the methodology of the present invention, after a defect map of a semiconductor wafer has been generated, each defect site and a corresponding known non-defective reference site is imaged by

a scanning electron microscope (SEM) to gather and store location and topographical data. This data is then analyzed by a rule-based core classifier using boundary analysis and topographical techniques to classify the defect as being in one of a number of predetermined core classes of defect. The defect is then further classified into one of an arbitrary number of variable subclasses (i.e., subclasses that cannot be discerned by the core classifier) using a "specific adaptive classifier" associated with the core class in which the defect has been placed, which employs sample defect image classifier methodology on a limited scale, for efficiency. If the core classifier or specific adaptive classifier cannot classify the defect into a core class, the defect is analyzed by a conventional full classifier.

The present invention utilizes the best attributes of three different types of classifiers to perform defect classification more quickly and reliably than prior art methodologies. It employs a core classifier for fast initial classification of defects into a predetermined number of core classes, the core classifier being able to work during start-up and ramp-up of a production line because it does not require examples of defects. It also uses specific adaptive classifiers in parallel with the core classes for local refinement within a core class. The present invention further employs a full classifier, but only on a limited basis for special types of defects that do not fit in to the core classification scheme. Thus, as the fabrication process matures and the types of defects of interest become more diverse, the specific adaptive and full classifiers can be trained as needed to perform more detailed defect classification.

None of the cited prior art references, alone or in combination, teaches or suggests an apparatus or a method that utilizes more than one type of classifier. Specifically, the references do not teach or suggest an apparatus or method that employs both a core classifier and a specific adaptive classifier, as required by the claimed invention. Independent claims 1, 10, 19 and 22

have been amended for clarity to specify that the specific adaptive classifier is trained by the user with a set of sample defect images. This amendment is supported, for example, at page 7, line 29-30 of the application.

Regarding the anticipation rejection of independent claims 1, 10, 19 and 22 based on Mizuno, as pointed out at paragraph 2 of the Office Action, this reference teaches the use of a core classifier to classify defects into one of a predetermined number of core classes. However, Mizuno fails to teach or suggest using a specific adaptive classifier associated with the one core class, and trained by the user with a set of sample defect images, to further classify the defect into a subclass, as required by independent claims 1, 10, 19 and 22. Rather, Mizuno teaches using a core classifier for this function. In other words, Mizuno uses a core classifier, or "rule-based" classifier, to initially classify defects, and also to subclassify the defects.

Mizuno's inspection technique is explained at col. 4:61 to col. 6:50 as including the steps of comparing the SEM image of the defect with a reference image, then performing a boundary analysis to initially classify the defect. The boundary analysis is performed by following a set of rules programmed beforehand (see col. 5:30 to col. 6:3). Another boundary analysis is then conducted to further classify the defect by size (see col. 6:4:32).

In contrast, the claimed invention performs subclassification of defects using an inventive "specific adaptive classifier" as described, for example, at page 7, line 28 et seq. of the application. The specific adaptive classifier of the present methodology is trained by the user with a set of sample defect images to classify a defect based on the defect's predicates. It does not operate based on comparing reference and defect images and performing boundary analysis, like Mizuno's rule-based classifiers. The specific adaptive classifier is an important feature of the claimed invention because, unlike conventional full classifiers that must classify every defect

as being in one of many classes (e.g., 10 classes), the inventive specific adaptive classifier analyzes only defects of the core class or classes with which it is associated (e.g., 1, 2 or 3 classes). Thus, the specific adaptive classifier is presented with a "sub-problem" (e.g., a defect that it knows is in one of, say, 2 or 3 classes) that is easier to solve than the total problem (a defect that could be in one of 10 or more classes). This limit on the domain of the specific adaptive classifier enables it to classify defects more reliably and faster than a conventional classic classifier, since the specific adaptive classifier needs to consider less predicates to reach its decision in most situations. Furthermore, the claimed specific adaptive classifier is more flexible than the rule-based sub-classification scheme of Mizuno, because it allows the user to easily modify and/or add defect classes as necessary.

Thus, Mizuno does not anticipate independent claims 1, 10, 19, and 22, because it does not disclose or suggest the step of classifying a defect as being in one of an arbitrary number of variant subclasses using a specific adaptive classifier trained by the user with a set of sample defect images and associated with one core class, as required by independent claims 1 and 22; and does not disclose or suggest a specific adaptive classifier trained by the user with a set of sample defect images and associated with one core class for classifying the defect as being in one of an arbitrary number of variant subclasses, as required by independent claims 10 and 19. Moreover, it would not have been obvious to modify the methodology or apparatus of Mizuno to yield the invention of claims 1, 10, 19 or 22, because Mizuno's rule-based classifiers operate on a completely different principle than the claimed specific adaptive classifier that is trained by the user with a set of sample defect images.

Consequently, claims 1, 10, 19 and 22 are patentable, as are claims 3-5, 12-14 and 24-26, which depend from claims 1, 10 and 22, respectively.

Regarding the obviousness rejection of claims 2, 11 and 23 based on the Mizuno and Chou references, Chou does not teach or suggest the recited specific adaptive classifier of independent claims 1, 10 and 22 missing from Mizuno. Chou teaches a rule-based classifier (see Chou, Abstract). Moreover, Chou does not teach a classifier associated with a particular core class, as claimed. Still further, Chou does not teach the claimed combination of a core classifier and a specific adaptive classifier associated with a particular core class. Therefore, any combination of Mizuno and Chou, however made, would still be missing the claimed specific adaptive classifier, and it would not have been obvious to add the claimed specific adaptive classifier to any Mizuno/Chou combination.

Consequently, claims 2, 11 and 23 are patentable.

Regarding the obviousness rejection of claims 6, and 15 based on Mizuno and page 11, lines 7-30 of the application, it is contended in the Office Action that the Applicant admits (at page 11, lines 7-30) that a plurality of specific adaptive classifiers as claimed in claims 6 and 15, each associated with less than a predetermined number of core classes, is in the prior art. This is not correct. There is no support at page 11 or anywhere else in the specification for the contention that Applicant considers the claimed plurality of specific adaptive classifiers to be in the prior art. In fact, the application is replete with statements as to the inventiveness of the claimed specific adaptive classifiers. See, for example, page 7, lines 28 et seq., distinguishing specific adaptive classifiers from prior art classic classifiers.

Since all the limitations of claims 6 and 15 are not found in the cited references, the rejection under § 103 should be withdrawn. Consequently, claims 6 and 15 are patentable.

Regarding the obviousness rejection of claims 7, 16 and 27 based on the Mizuno and Nakamura references, Nakamura does not teach or suggest the recited specific adaptive

classifier, trained by a user with a set of sample defect images, of independent claims 1, 10 and 22 (from which claims 7, 16 and 27 depend) missing from Mizuno. Nakamura teaches a rule-based classifier (see Nakamura, Abstract). Moreover, Nakamura does not teach a classifier associated with a particular core class, as claimed. Still further, Nakamura does not teach the claimed combination of a core classifier and a specific adaptive classifier associated with a particular core class. Therefore, any combination of Mizuno and Nakamura, however made, would still be missing the claimed specific adaptive classifier, and it would not have been obvious to add the claimed specific adaptive classifier to any Mizuno/Nakamura combination.

Consequently, claims 7, 16 and 27 are patentable.

Regarding the obviousness rejection of claims 8, 9, 17, 18, 20, 21, 28 and 29 based on Mizuno, Nakamura and the admitted prior art classic classifier techniques discussed at page 12, lines 7-13 of the application (the APA), it is contended that it would have been obvious to combine the cited references to yield the invention of claims 8, 9, 17, 18, 20, 21, 28 and 29 because the techniques of the APA are well-known in the art.

Applicant disagrees. As discussed above, the both Mizuno and Nakamura are missing the recited specific adaptive classifier, trained by a user with a set of sample defect images, of independent claims 1, 10, 19 and 22, from which claims 8, 9, 17, 18, 20, 21, 28 and 29 depend. The APA does not furnish a teaching of the inventive specific adaptive classifiers. Therefore, any combination of Mizuno and Nakamura and the APA, however made, would still be missing the claimed specific adaptive classifier, and it would not have been obvious to add the claimed specific adaptive classifier to any Mizuno/Nakamura/APA combination.

Furthermore, Applicant submits that it would not have been obvious to combine the APA with Mizuno and Nakamura, because the APA relates to a completely different classifier

technology than the other two cited references. Both Mizuno and Nakamura relate to rule-based classifiers that use a comparison of reference and defect images followed by boundary analysis, while the APA relates to training techniques for classic classifiers that use multiple sample defect images. Thus, the APA's techniques are not relevant to Mizuno and Nakamura's methodology, and vice versa, and a skilled artisan would therefore not have been motivated to combine them.

Consequently, claims 8, 9, 17, 18, 20, 21, 28 and 29 are patentable.

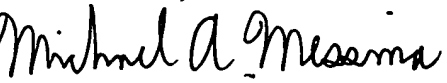
Reconsideration and withdrawal of the rejection of claims 1-30 under 35 U.S.C. §§102 and 103 are respectfully requested.

Accordingly, it is believed that all pending claims are now in condition for allowance. Applicant therefore respectfully requests an early and favorable reconsideration and allowance of this application. If there are any outstanding issues which might be resolved by an interview or an Examiner's amendment, the Examiner is invited to call Applicant's representative at the telephone number shown below.

To the extent necessary, if any, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted

McDERMOTT, WILL & EMERY



Michael A. Messina
Registration No. 33,424

600 13th Street, N.W.
Washington, D.C. 20005-3096
(202) 756-8000 MAM/mcm
Date: August 13, 2002
Facsimile: (202) 756-8087